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Patent Application

for

PROCESS AND APPARATUS FOR PICKLING METAL STRIPS

by

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Cross-Reference to Related Application

[0001] This application claims the benefit under 35 U.S.C. § 119 of Austrian Patent Application No. A 1194/2002, filed August 7, 2002, which is hereby incorporated by reference in its entirety.

Field of the Invention

[0002] The present invention relates to a process of and apparatus for preventing spots from forming and removing formed spots on a material strip being pickled. More particularly, the present invention relates to a process of and apparatus for preventing spots from forming and removing formed spots on a material strip that has come to a standstill during the pickling process. Still more particularly, the present invention relates to a process of and apparatus for reversing

the direction of travel of the material strip and/or spraying the material strip with pickling solution to prevent the formation of and remove any formed spots on the material strip.

Background of the Invention

[0003] The pickling of steel is a process for removing scale from the surface of the steel that is present after various forming operations. Continuous sheets of steel are typically carried through several acid baths by immersing the strip completely in the baths for sufficient time to remove the scale. It is necessary to remove the acid residue from the steel after the pickling step to prevent corrosion, staining or spotting of the surface.

[0004] Pickling plants for treating a continuous steel strip usually include a strip rinsing facility downstream of the acid pickling stage to remove any residual pickling acid still adhering to the surface of the strip as the strip exits the pickling section. This rinsing process can be implemented by spraying the rinsing solution directly onto the strip. Alternatively, the strip can be rinsed by pulling the strip through a bath of the rinsing solution. In the pickling plants that have been built to date, spots form on the strip surface due to the rinsing solution drying on and oxidizing when the strip, which is generally continuously fed through the plant in normal operation, comes to a standstill. In pickling plants where the rinsing solution is sprayed through nozzles directly onto the strip, the strip surface suffers serious discoloration due to oxidation if the air and rinsing solution are allowed to act on the strip simultaneously during prolonged stoppages of the strip movement through the rinse station.

[0005] To alleviate this situation, it has been suggested that the rinsing solution be applied through nozzles and that the rinsing

station be flooded with the rinse solution when the forward movement of the strip is interrupted. The station can be flooded to a level that completely covers the steel strip, thereby preventing oxygen from contacting the steel strip during the stoppage. Complete immersion of the strip in rinsing solution reduces the staining on the strip during periods when the strip is stopped.

[0006] Although systems were developed to permit flooding of the strip if the strip comes to a standstill, the rinsing solution requirement is considerable and the rinsing section must be sized to handle this large quantity of rinsing solution.

[0007] Alternatively, it has been suggested that inert or noble gases could be blown into the rinsing section or onto the strip surface in the rinsing section for periods when the strip comes to a standstill. However, at least one additional medium that is not present in other treatment phases, unlike the pickling or rinsing solutions, must be introduced to the pickling plant. Appropriate sources, as well as piping and dosing devices, must be provided. A system of this type was made public in EP 707 668 Al, for example.

[0008] Thus, the present invention provides an improved process and apparatus that prevents spots from forming on the material strip being treated if it comes to a standstill in the pickling plant, and requires relatively little equipment and control instrumentation, as well as using solutions that are already available in the pickling plant.

Summary of the Invention

[0009] The present invention relates to a process of and apparatus for preventing spots from forming and removing formed spots on a material strip during the pickling process. In normal operation, the material strip passes continuously through at least one pickling

section and then enters at least one rinsing section, in which the surface of the material strip is sprayed with a rinsing solution. The rinsing solution is then removed by at least one pair of squeeze rollers. Shower nozzles or showers are provided in the rinsing section to apply the rinsing solution to the material strip.

[0010] The process and apparatus of the present invention prevents spots from forming and removes formed spots on the material being treated if it comes to a standstill in the plant with the least amount of equipment and control instrumentation. Solutions are used that are already available in the plant, such as the pickling and rinsing solutions. Pickling solution may be applied to the surface of the material strip, at least in sections, if the strip comes to a standstill to prevent the formation of or to removed formed spots.

[0011] A first embodiment of the present invention relates to a method of pickling a material strip. The material strip is passed in a first direction through at least one pickling section to form a first pickled material strip. The first pickled material strip is passed in the first direction through at least one rinsing section to form a first rinsed material strip. The first rinsed material strip is sensed when it comes to a standstill. Pickling solution is applied to at least a portion of the first rinsed material strip when the first rinsed material strip has come to a standstill to form a second pickled material strip.

[0012] A second embodiment of the present invention relates to a method of pickling a material strip. The material strip is passed in a first direction through at least one pickling section to form a first pickled material strip. The material strip is passed in the first direction through at least one rinsing section to form a first rinsed material strip. The material strip is sensed when it comes to a standstill. The first rinsed material strip is moved in a second

direction that is opposite to the first direction after sensing the standstill. The first rinsed material strip is passed back into the pickling section to form a second pickled material strip.

[0013] Other objects, advantages and salient features of the invention will become apparent from the following detailed description, which, taken in conjunction with the annexed drawings, discloses preferred embodiments of the invention.

Brief Description of the Drawings

[0014] Referring now to the drawings that form a part of the original disclosure:

[0015] FIG. 1 is a schematic diagram of the pickling process according to the present invention during normal operation in which the material strip moves in a first direction;

[0016] FIG. 2 is a schematic diagram of the pickling process in which the material strip is moving in a second direction that is opposite to the first direction;

[0017] FIG. 3 is a schematic diagram of the pickling process of FIG. 2 in which the material strip is again moving in the first direction;

[0018] FIG. 4 is a schematic diagram of the pickling process according to another embodiment of the present invention in which spray nozzles that deliver pickling solution are disposed in the rinsing section; and

[0019] FIG. 5 is a schematic diagram of the pickling process of FIG. 4 in which the material strip is moving in the second direction.

Detailed Description of the Invention

[0020] The process and apparatus of the present invention prevents spots from forming and removes formed spots on the material strip by

applying pickling solution to the surface of the material strip, at least in sections, if the strip comes to a standstill. This retains the quality of the material strip being treated even after the strip comes to a standstill, while still avoiding flooding of the material in the rinsing section. The spots that have formed are removed efficiently when the surface is treated with pickling solution again. Preferably, once the surface of the material strip has been treated again with pickling solution, the material strip is then again treated with rinsing solution. Preferably, the pickling solution is a pickling acid, such as hydrochloric, sulfuric, and nitric acids, and mixtures thereof. Preferably, the material strip is a metal, such as steel or stainless steel.

[0021] In normal operation, as shown in FIG. 1, the material strip M passes continuously in a first direction 11 through at least one pickling section 1, which may be a bath or spray, and then enters at least one rinsing section 2. The surface of the material strip is sprayed with a rinsing solution by shower nozzles 4 or showers disposed in the rinsing section 2. A typical pickling process is described in commonly owned U.S. Patent Serial No. 09/654,349, which is hereby incorporated by reference in its entirety. The rinsing solution is then removed by passing the material strip M through at least one pair of squeeze rollers 5. Occasionally, the material strip comes to a standstill. Some reasons that may cause the standstill include, but are not limited to, a change of the material strip, a failure on the surface of the material strip, and a breakdown during any of the preceding steps (such as a breakdown of the pickling plant).

[0022] According to a first advantageous embodiment of the pickling plant, a sensor 21 senses when the material strip M comes to a standstill. The sensor 21 transmits a signal to the control system (not

shown), which causes the material strip M to run in a second direction 15, as shown in FIG. 2, to avoid the formation of and to remove formed spots on the material strip. The second direction 15 is opposite to the first direction 11 in which the material strip M runs during normal operation. Running the material strip M in the second direction 15 introduces a portion of the material strip that had entered the rinsing section 2 back into the pickling section 1 to prevent formation of and to remove formed spots on the material strip. The running direction of the material strip M is then returned from the second direction 15 back to the first direction 11, and the portion of the material strip that has been retreated with pickling solution in the pickling section 1 is again brought back to the rinsing section 2, as shown in FIG. 3. Thus, according to the first embodiment of the present invention, no additional components are needed in the rinsing section 2 to prevent the formation of and to remove formed spots on the material strip M when the material strip comes to a standstill. Since the exposed surface of the material strip starts to oxidize within approximately minute, preferably the sensor causes the material strip to run in the reverse direction when the material strip is idle for longer than approximately one minute.

[0023] Either in addition to or as an alternative to reversing the direction of travel of the material strip M into the pickling section 2, the material strip may also be sprayed again with pickling solution, as shown in FIG. 4. Preferably, the material strip M is sprayed with pickling solution before the material strip is reversed back into the pickling section 1, if so planned as shown in FIG. 5. Preferably, the material strip M is sprayed with the pickling solution while the material strip is still at a standstill in the rinsing section 2. Again, since the exposed surface of the material strip starts to oxidize within

one minute, preferably, the sensor causes the material strip M to be sprayed again with pickling solution when the material strip is idle for longer than approximately one minute.

[0024] A program in the control system (not shown) causes the material strip M to automatically reverse the running direction from the first direction 11 to the second direction 15 back into the pickling section 1 when stoppage of the material strip is detected by sensor 21. Once the portion of the material strip M has been reversed from the rinsing section 2 back into the pickling section 1, the running direction of the material strip is returned from the second direction 15 back to the normal operating direction (first direction 11). Thus, the portion of the material strip M that has been retreated with pickling solution is again passed through the rinsing section 2. No structural changes are required to be made to the pickling plant to implement this new control program. The only required changes to the plant are to modify or re-program the control system. The amount of time that the material strip is left in the pickling section 1 after a standstill and/or the amount of pickling solution applied to the material strip after standstill is dependent on the length of the standstill and is calculated and controlled by the program in the control system.

[0025] With only slight structural changes, however, the present invention may also include connecting shower nozzles 39 or showers to a feed pipe for pickling solution and installing valve fittings 31 to allow for the optional supply of either pickling or rinsing solution. In this embodiment of the present invention, there is no need to modify the control system to handle a different material strip guiding variant. The spray nozzles 4 or showers disposed in the rinsing section 2 may be modified to provide either the pickling solution or the rinsing solution, depending on the present situation. As shown in FIGS. 4

and 5, valves 31 may be added to nozzles 39 to provide either rinsing solution or pickling solution. A pickling feed line 35 and a rinsing solution feed line 37 are connected to the valve. The valve 31 is operated to switch between dispensing rinsing solution or pickling solution through the nozzle 39. Alternatively, new nozzles 41 may be added to dispense only the pickling solution.

[0026] As shown in FIG. 1, the normal direction of movement of the material strip M to be treated is indicated by arrow 11. A rinsing section 2 is provided downstream of a pickling section 1, such as a tank or similar device, that is filled with a pickling solution. In the rinsing section 2, there are preferably several spray nozzles 4 or showers through which the rinsing solution is applied to the material strip M. Squeeze rollers 13 are provided at the inlet to the pickling section 1, and squeeze rollers 5 are also provided at the outlet of the rinsing section 2.

[0027] If the strip M is at a standstill for a period of several minutes, for example, for reasons dictated by plant operations, spots may form on the portion of the material strip that is currently in the rinsing section 2. In order to prevent spots from forming and/or to remove formed spots, and, thus guarantee the high quality of the material strip M being treated, the material strip is either sprayed once again with pickling solution through the existing spray nozzles 39 or showers (FIG. 4), and/or the material strip M is run in the second direction 15 (FIG. 2) over a certain distance in the opposite direction to normal operation until that portion of the strip is submerged again in the pickling solution in the pickling tank 1. Any pickling solution that is carried out of the pickling section 1 by the material strip M due to being run in the second direction 15 is removed by the squeeze rollers 13 provided at the inlet to the pickling section 1 and collected

in a tray 3 upstream of the pickling section. The material strip M may remain briefly at a standstill until any formed spots have dissolved, or the material strip may be transported immediately in the normal running direction as soon as that portion of the material strip has been submerged in the pickling solution in the pickling section 1.

[0028] In a first embodiment of the present invention, the material strip M is passed in a first direction 11 through at least one pickling section 1 to form a first pickled material strip, as indicated by portion B in FIG. 1. The first pickled material strip is passed in the first direction 11 through at least one rinsing section 2 to form a first rinsed material strip, indicated by portion A of FIG. 1. The first rinsed material strip is sensed when it comes to a standstill by sensor 21. Pickling solution is applied to at least a portion of the first rinsed material strip when the first rinsed material strip has come to a standstill to form a second pickled material strip, as shown in FIG. 4. The pickling solution may be applied either through nozzles 39 fitted with valves 31 to dispense pickling solution or through nozzles 41 that dispense only pickling solution. The second pickled material strip may then be moved in the second direction 15, as indicated in FIG. 5, to pass the second pickled material strip into the pickling solution 1 to form a third pickled material strip, as indicated by portion A of the material strip in FIG. 5. The direction of travel is then changed back to the first direction 11 and the third pickled material strip is passed through the rinsing section 2 to form a second rinsed material strip, as indicated by portion A of the material strip in FIG. 4. The second rinsed material strip is then passed through at least one pair of first squeeze rollers 5 to remove rinsing solution from the second rinsed material strip.

[0029] In another embodiment of the present invention, the material strip M is passed in a first direction 11 through at least one pickling section 1 to form a first pickled material strip, as indicated by portion B in FIG. 1. The first pickled material strip is passed in the first direction 11 through at least one rinsing section 2 to form a first rinsed material strip, as shown by portion A in FIG. 1. A sensor 21 senses when the first rinsed material strip comes to a standstill. The first rinsed material strip is moved in a second direction 15 that is opposite to the first direction after sensing the standstill, as shown in FIG. 2. The first rinsed material strip is passed back into the pickling section 1 to form a second pickled material strip, as indicated by portion A in FIG. 2. Once the second pickled material strip has been formed, the direction of travel is changed back to the first direction 11, as indicated in FIG. 3. The second pickled material strip is passed through the at least one rinsing section 2 to form a second rinsed material strip, as indicated by the portion A of the material strip in FIG. 3. The second rinsed material strip is then passed through the at least one first pair of squeeze rollers 5 to remove rinsing solution.

[0030] As indicated by portions B of the material strip M in FIGS. 2 and 5, when the material strip is moved in the second direction 15 of travel the portion of the material strip that had been in the pickling section 1 is passed back through the at least one pair of squeeze rollers 13. A collection tray 3 may be used to collect the pickling solution removed from the material strip M by the squeeze rollers 13.

[0031] While advantageous embodiments have been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.